ZAMBIA TRADE AND INVESTMENT ENHANCEMENT PROJECT (ZAMTIE)

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ZAMTIE SUPPORT FOR THE DEVELOPMENT OF THE ZNFU-ZESCO FOOD SECURITY SPECIAL ELECTRICITY TARIFF AND THE POWER QUALITY – RELIABILITY – ENERGY EFFICIENCY EARNINGS PILOT PROJECT

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1. INTRODUCTION

1.1 Electricity Tariff Adjustment

On 29th September 2000, ZESCO applied to the Energy Regulation Board (ERB) for its intention to revise retail electricity tariff by 16 % based on the automatic tariff adjustment formula (ATAF). This was in accordance with the provisions of Section 8 of the Electricity Act, CAP 433 of the Laws of Zambia. Objections to the revision of the electricity tariffs were received from the Zambia National Farmers' Union (ZNFU) and the Zambia Consumer' Association. The objections and ZESCO's reactions thereto were raised at a public hearing held on 24th November 2000. The Zambia Consumers' Association requested for the ATAF to be scrapped. The positions of the ZNFU and ZESCO, the rulings of the ERB, and observations of the Power Rehabilitation Project World Bank mission are summarised in Appendix E.

1.2 Evolving Terms of Reference

The resolution process of the tariff issues is divided into three parts as follows:

Part I: Development of the electrical engineering basis for a special tariff for farmers to be developed by ZESCO in line with ERB's rulings and the ZNFU position.

Part II: Development of special tariff proposals taking into consideration efficient energy usage, power quality and reliability of supply problems.

Part III: Development of the Energy Efficiency Earnings Pilot Project which integrates supply-side and demand-side management issues, and takes into consideration the existing power quality and reliability problems affecting farming productivity.

1.3 Methodology

The steps involved in developing the quantitative basis for the special tariff proposals were as follows:

1) Analyse the new ZESCO tariff structure (Table A3) and implications on the various categories taking into consideration: the ZESCO daily load profile Table A1), Consumption and contribution to system peak demand (Table A2).

2) Jointly develop specific supply-side and demand-side tariff adjustment strategies.
3) Recommend special tariff proposals for farmers based on specific supply-side and demand-side tariff adjustment activities.

Table A1 ZESCO Daily Load Profile

	Day Peak Load 13-14 hours	Off Peak Load 22-06 hours	Evening Peak load 20 hours
Percent of 24 hour average	130 %	70-80 %	Largest Contribution from Domestic Consumers

Note:

1. Possibilities of load shifting from peak to off-peak hours is in the range of 20-25 % of total capacity demand.
2. About 100 MW load shifting should give a flat load curve.

Table A2 Agriculture and Forestry sector Energy Consumption and Contribution to System Peak Demand

Distrib-ution Voltage Level	Energy MWh	kW Per consu-mer	No. Consu-mers	Day Peak kW	Evening Peak kW	Load Fact or	Total Load Factor	Simulta-neity Factor
66-33 kV	90,000	17,600	1	17,600	17,600	0.58	0.69	0.85
11-33 kV	24,000	2,500	2	5,000	5000	0.56	0.77	0.72
0.4 kV	63,219	12.2	1296	15,862	15,862	0.46	0.79	0.58
Total	177,552		1299	38,442	38,442			0.72
Total Contri-bution to System Peak				27,729	27,729			
Total Zambia 1995/96	6361850		151,702	879,364	908,019			
Losses 10%				86,799	104,235			
Total Zambia 2000/01	7573000		434,314					

Table A3: ZESCO Electricity Tariff Effective February 2001

	A1	B1	C1	C2	D1
Electricity Tariff Charges In Zambian Kwacha (ZK) **1 US$=3600 ZK**	**Fixed Charge per Month**	**Active Energy Charge per kWh**	**Reactive Energy Charge per kVARh**	**Low Power Factor Net-Reactive Power Charge per kVAR Per month**	**Peak Capacity(MD) Charge per kVA per Month**
Un-metered Residential					
L1 up to 2A	4,200 7.2 % of MD1				
L2 above 2A	15,200 26% of MD1				
Metered Residential					
R1 up to 300 kWh		60 71% of MD1			
R2 301-700 kWh		85 100% of MD1			
R3 above 700 kWh	5000 8.6% of MD1	140 164% of MD1			
Commercial	O601 hours to 2159 hours				
	25,000 43% of MD1	140 164% of MD1			

Social Services	O601 hours to 2159 hours				
Water Pumping, Street lighting, Hospitals, Churches, Schools, Orphanages.	20,000 34% of MD1	116 136% of MD1			
Maximum Demand	O601 hours to 2159 hours				
MD1 Capacity up to 300 kVA	58,165 100% of MD1	85 100% of MD1			5,939 100% of MD1
MD2 Capacity Between 300-2000 kVA	116,330 200% of MD1	73 86% of MD1			11,111 187% of MD1
MD3 Capacity Between 2000-7500 kVA	232,660 400% of MD1	54 64% of MD1			16,754 282% of MD1
MD4 Capacity above7500 kVA	465,320 800% of MD1	45 53% of MD1			16,847 283% of MD1

2. PART I : Tariff Electrical Engineering Basis Development

2.1 ZESCO TARIFF STRUCTURE

The electricity tariff in Table A3 is divided into five categories, namely : Un-metered residential (Lifeline L1 and L2), metered residential (R1, R2, and R3), commercial , social services, and maximum demand (MD1, MD2, MD3, and MD4). The tariff consists of three components, namely:

1) A fixed charge (A1) which reflects charges for metering , billing and part of the cost of the service line in ZK / month. This charge is independent of consumption.
2) An active energy consumption charge in ZK/ kWh.

This includes running or variable operating costs which are proportional to the energy output or consumption. This includes variable maintenance costs, output dependent power system operating costs , fuel costs and where applicable a royalty charge per kWh generated.

3) A peak maximum demand capacity charge in ZK/ MD-kVA per 30-minute averaging interval. The peak kVA maximum demand has two components, namely: the peak kW active power maximum demand and the peak kVAR reactive power maximum demand.
The above maximum demand charge consists of capacity related standing charges which are independent of energy output or consumption. This includes fixed maintenance costs, capacity investment costs, interest, insurance, annual cost of wages and taxes, depreciation, and where applicable a royalty charge per kW per year generated.

2.2 Distribution of Costs and Conditions

The distribution of costs between the consumer categories is fairly sensitive to assumptions concerning power factor, load factor, and simultaneity factors at various generation, transmission and distribution power demand points. The fixed charge is, where necessary, used to get a fair distribution of costs between the customer categories with fairly different consumption patterns. It is also used to get consistency between the various maximum demand tariffs.

Most of the costs for the electricity supply to small customers are fixed. The capacity demand of small customers is not possible to measure on a regular basis for each customer. However, the size of the energy consumption will normally correspond with the utilised capacity. The utilisation of the generation and transmission system for these customers is dependent on the amount of energy consumed. The cost of those parts are mirrored by the active energy charge.

3. SUPPLY-SIDE COST REDUCTION ACTIONS

3.1 Quality of Supply

Introduce a reverse penalty charge to ZESCO for persistent inadequate quality of supply.

3.2 Frequent Power-Cut Damage

Introduce a reverse penalty charge to ZESCO for persistent inadequate reliability of service of supply. Alternatively introduce an interruptible power supply electricity tariff in areas experiencing very high frequency of unscheduled power supply interruptions.

3.3 Excess Maximum Demand Charge

Introduce an excess peak reactive power charge as outlined in Section 2.4 . Care should be taken that the local transformer rated kVA is not exceeded. See Appendix B3 for correct sizing of distribution transformers.

3.4 Diversity Factor

Apply generation, transmission, and distribution simultaneity factors in computing the total maximum demand kVA charge. See Appendix B5.

3.5 Off-Evening Peak and Seasonal Tariffs

Introduce tariffs incorporating time of use and seasons similar to tariffs mentioned in Appendix E1, Sections 2.4 and 2.5 .

4. DEMAND-SIDE COST REDUCTION ACTIONS

4.1 Systematic Load factor and Power Quality Management

Reduce your total electricity bill by levelling load factors at each power demand point and maintaining high power quality standards through proper maintenance of electro-mechanical equipment throughout the farm farm. Special care should be taken in validating the integrity of the earthling circuits of all structures and electrical equipment to minimize electrocution of humans and damage due electrical fires.

4.2 Distributed Power Factor Correction

Avoid excess peak maximum demand charges (C2 and D in Appendix A10) by adopting load point power factor correction throughout the farm.

4.3 Site specific Optimal Mix of Tariffs

Select the best mix of tariff categories at a farm that minimizes the total monthly bill being offered by ZESCO.

5. PART II : Proposed Tariff Recommendations

5.1 Proposed Special Tariff for ZNFU Farmers

To include all farming undertakings affliated with the ZNFU in all tariff categories **.**

5.2 Supply Side Electricity Charges

A = Fixed charge per month to cover portion of operating costs

A1 = Fixed charge per month to cover portion of ZESCO costs

Comment 1:
Based on ZESCO's Electricity Tariff Study

A2 = Fixed reverse-charge to cover a portion of emergency and standby electricity supplies and/or production losses due to frequent unplanned power outages exceeding X hours/month

Comment 1:
To address reliabiliy of supply problems sited in ZNFU Position Paper attachments. This charge to should be in the order of the value of un-served energy to the customer per ZESCO Electricity Tariff Study

A3 = Fixed reverse-charge to cover part of repair or replacement costs of equipment damaged due to verifiable voltage, frequency and power quality inadequacies

Comment 1:
To address quality of electricity supply problems ZNFU Position Paper attachments.

B = Time of Use Active Energy Charge

Comment 1:
Request in ZNFU Position Paper Request, Standard Practice internationally as in Appendix D for "Economy Tariff"

B1 = Day time Peak Energy Charge ZK/kWh

B2 = Day time Off-Peak Energy Charge ZK/kWh

B3 = Night time Peak Energy Charge ZK/kWh

B4 = Night time Off-Peak Energy Charge ZK/kWh

C = Reactive Energy Charge

Comment 1:
Power Factor Correction can reduce MD kVA Drastically thereby eliminating the need for MD Capacity Charges; See Appendix B3. Therefore for deserving demand points, with adequate Power Factor Correction on a farm, the MD Capacity Charge is not necessary, only the kVARh consumption charge would be necessary. This is because the Maximum Load demand will always be below the supply Transformer rated kVA defined in Appendix B1

C1 =Direct Reactive Energy Charge ZK/ kVARh
OR
C2 = Low Power Factor Penalty Charge ZK/ Net kVAR
Net MD kVAR = MD Meter kVAR – kVAR at Ref–Power-Factor
Reference Power Factor = 0.80

D = Distributed Net-Maximum-Demand Peak Capacity Charge
= DG (Generation) + DT (Transmission) + DD (Distribution)

Comment 1:

This practice would require ZESCO to begin measuring the simultaneity factors at declared reference Generation Nodes, Transmission Nodes and Main Distribution Nodes for a designated groups of customers (See Table A2) . If this was done to day there would be more than 50 percent reduction in MD Charges per customer group

D1 = Day time Peak MD Charge ZK/ kVA

D2 = Day time Off-Peak Net-MD Charge ZK/ Net kVA

D3 = Night time Peak MD Charge ZK/ Net kVA

D4 = Night time Off-Peak Net-MD Charge ZK/ Net kVA

Net MD kVA = MD Meter peak kVA – MD Meter off peak kVA

MD Meter Peak < TX Rated Design Load on
Transformer Natural Cooling Rating

Diversity Factor = 1/ (Simultaneity Factor)

DG (Generation) = (Incremental Generation Capacity Charge)/ (Generation Diversity Factor)

DT (Transmission) = (Incremental Transmission Capacity Charge)/ (Transmission Diversity Factor)

DD (Distribution) = (Incremental Distribution Capacity Charge)/ (Distribution Diversity Factor)

Comment 2:

1) MD KVA Charges can be reduce first by raising the power factor , secondly by raising the loadfactor by cyclic load scheduling,and thirdly by switching off un-necessary loads, and fourthly by basing charges on the NET-kVA Maximum Demand..
2) The highest kVA bills result when both the Power factor and the Load Factor at a demand point are low.

Table A4 : ZNFU Energy Economy Off-Peak Tariffs

	A1	B1	C1	C2	D2
Electricity Tariff Charges In Zambian Kwacha (ZK) **1 US$=3600 ZK**	**Fixed Charge per Month**	**Active Energy Charge per kWh**	**Reactive Energy Charge per kVARh**	**Low Power Factor Net-Reactive Power Charge per kVAR Per month**	**Peak Capacity(MD) Charge per Net-kVA per Month**
Un-metered Residential					
L1 up to 2A	4,200 7.2 % of MD1				
L2 above 2A	15,200 26% of MD1				
Metered Residential					
R1 up to 300 kWh		60 71% of MD1			
R2 301-700 kWh		85 100% of MD1			
R3 above 700 kWh	5000 8.6% of MD1	140 164% of MD1			
Commercial	2200 hours to 0600 hours				
	25,000 43% of MD1	140 x 50% (PF>.8)			
Social Services	2200 hours to 0600 hours				
Water Pumping, Street lighting, Hospitals, Churches, Schools, Orphanages.	20,000 34% of MD1	116 x 50% (PF>.8)			
Maximum Demand	2200 hours to 0600 hours				

MD1 Capacity up to 300 kVA	58,165 100% of MD1	85 x 50% if interruptible		Negotiable percent of D1	5,939 x 50%
MD2 Capacity Between 300-2000 kVA	116,330 200% of MD1	73 x 50% if interruptible		Negotiable percent of D1	11,111 x 50%
MD3 Capacity Between 2000-7500 kVA	232,660 400% of MD1	54 x 50% if interruptible		Negotiable percent of D1	16,754 x 50%
MD4 Capacity above7500 kVA	465,320 800% of MD1	45 x 50% if interruptible		Negotiable percent of D1	16,847 x 50%

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The adoption of a well-articulated Time-of-Use tariff structure would be an important step to encouraging sectors such as farming to actively review consumption practices to the mutual benefit of ZESCO and the consumers.

Certain consumers are constrained by the nature of their operations to consume most of their power during periods of peak demand. Farmers, however, are well placed to shift a significant part of their consumption to periods of minimum demand on the ZESCO system. Activities such as irrigation of winter crops, crop drying and workshop operations are examples.

If the tariff structure can demonstrate significant savings, then the consumers would be compelled to restructure their consumption patterns. The premise for benefits should be efficient energy utilization.

The most significant feature is the relative saving enjoyed by consumers by careful planning of their consumption patterns through:

1) Power factor correction;
2) High load factor and off-Peak hours energy use;
3) Distributed peak-capacity-charge reduction due to variations in power system simultaneity factors in generation, transmission and distribution; and
4) Demand Side Management focused on high productivity, energy waste

reduction and energy conservation through use of high efficiency electrical equipment such as motors.

6.2 Recommendations

The existing standard tariff should be converted into peak rates for farmers. The off-peak special tariff should then be discounted as follows:

Capacity Charge – 50% discount on standard tariffs
Energy Charge – 50% of standard tariffs if interruptible.

7. PART III: ENERGY EFFICIENCY EARNINGS PROGRAMME

7.1 World Energy Efficiency Programmes

Energy efficiency (with an emphasis on earnings) programmes are in place in all industrialised countries. this is done generally through legislation, by providing information and encouraging energy efficient practice and by supporting energy service companies.

Why Save Energy?

1) Energy should be saved to save money through efficient use
2) Energy saving improves the environment by reducing pollution
3) The process of energy savings gives you understanding of current use and the likely costs of any fuel or electricity price changes.

Are there Easy Earnings to be made?

Energy savings are among the easiest to make and can greatly cut production costs. Recent case studies from South Africa show that it is easy to make energy savings. About 60% of these, in the three participating industries, were without significant investment in new capital. Furthermore, none of the energy saving projects had an investment payback period of over one year.

7.2 SADC Initiative:

SADC Partnership Programme
The Canadian-funded SADC Industrial Energy Management Project (SIEMP), now in its sixth year, has embarked on a new programme: the development of formal partnerships with SADC training providers.

Training Materials
The SIEMP project has developed a range of training resources, including a short introductory course called " Seven Steps to Energy Maagement Awareness" .

Core Training Programme
SIEMP completed its original mandate in March 2000, to provide exemplary energy management training in eleven SADC countries (including Zambia) through presentation of its 2Core Training Programme (CTP).The core training programme contains 16 modules and four appendices and sample data recording sheets.

7.3 South African Initiative

3E Strategy
South Africa has recently launched an industrial energy efficiency drive under the banner of the '3E strategy'. Two national energy efficiency agencies provided strategic advice and information for this project. They are the Energy Technology Support Unit (ETSU), which manages the British Energy Efficiency programme for industries, and NOVEM, the Netherlands agency for Energy and the Environment.

Increase in GDP
According to the Minister of the Department of Minerals and Energy (DME), Mrs Pumzile Mlambo-Nguka,, between 15% and 20% of energy consumed could be saved through efficiency programmes and would increase the countries GDP by at least 3% .[Energy Management News Vol. 6 No. 4 , Dec 2000 pp42-44]

Purpose for Programme
The purpose of this drive is to show how easy it is to increase profits by improved industrial energy efficiency and to explain how it can be done. A strategy for implementation the '3E or Energy efficiency Earnings Strategy' – is outlined simply and clearly in materials that have been produced by the consortium of : DME, EU, Dutch Ministry of Economic Affairs, UCT's Energy Research Institute, Eskom's Technology Services International's Energy Consulting Services (ECS), The Dutch energy agency (NOVEM) and the British Energy Technologies Support Unit (ETSU).

7.4 ZNFU Initiative

To be developed by ZESCO and the ZNFU in concert with the Energy Regulation Board for increased productivity in the Agriculture Sector of the Zambian Economy.

3E Programme Participants

FARMERS AND AGRO-BUSINESS ENTERPRISES
ZNFU
ZESCO
ERB

3E Programme Phases

Phase I	:	Development of 3E Programme Objectives , Scope and tariff negotiations December 2001- June 2002 (7 months duration at 10 man-days per month)
Phase II	:	Definition and Implementation of Pilot Project July 2002 - September 2002 (3 months duration at 10 man-days per month)
Phase III	:	National Scale Expansion of Pilot Project October 2002 – December 2002 (3 months duration at 10 man-days per month)

3E Programme Development Activities

1. Executive Briefs and Meetings:

(a) Continue to negotiate as well as conduct documentary research on electricity tariff structures applicable to farming and Agro-Business Enterprises (Domestic, Regional, International).

(b) Preparation of technical briefs leading to ZNFU-ZESCO-ERB Energy Efficiency Earnings Programme for Farmers.

(c) Consultations and Pre-Meeting strategy preparations and Executive Briefs.

2. Enhance ZNFU's capability in:

(a) Interpreting and understanding the power quality and reliability minimum performance standards; and maximum demand tariff structures.

(b) Developing contractual instruments for addressing power quality, reliability of supply problems and special electricity pricing options and mechanisms.

(c) Specifying appropriate portable instrumentation for monitoring and verification of: power quality and reliability of supply indices, power and energy supply and demand indices, and electricity usage profile , consumption billing estimates.

3. Advise ZNFU Board, ZNFU members on:

(a) the costs and benefits of the 3E Programme integrating the Utility Supply-Side and Farmers Demand-Side for increased food security for Zambia.

(b) technical issues arising from communications between the 3E Programme Participants.

8. PROGRESS TO-DATE

8.1 Special Tariff for MD-Farmers

In order to increase maize production in Zambia: ZESCO and ZNFU agreed on the following special tariff for farmers who are members :

50% Capacity Charge Reduction and 20% Energy Charge Reduction all year round, subject to:

(a) A minimum 30 Hectares of maize to be planted

(b) 30% of irrigation activities should be in the night to coincide with the national off-peak periods.

(c) Review annually by both ZESCO and ZNFU.

8.2 3E Pilot Project Preparations

Preparations are at an advanced stage involving:

(a) Sending members of the project teak to South Africa specialised training in power quality, reliability and energy efficiency management integrating the supply-side and demand-side.

(b) Development of a project proposal to cover the selected study area from Chisamba to Mazabuka.

(c) Identification of the requisite test equipment and ZNFU capital contributions and monitoring personnel.

Appendix : Position and Decisions on Tariff Revision

Appendix E1 ZNFU Position

The Zambia National farmers' Union (ZNFU) stand on the ZESCO tariffs adjustment is that it will raise the cost of production in the agriculture sector. This will make Zambian agricultural produce uncompetitive in the SADC region and COMESA markets. The ZNFU is concerned that the macro focus on agricultural development has been lost. Critical public utilities like ZESCO are now expected to compete with farmers for survival. The farmers are currently operating below break-even and pushing electricity charges higher will lead to the total collapse of the agriculture sector, including the floriculture and horticulture sub-sectors.

Twice yearly the ZNFU has had to present their position to the Energy Regulation Board (ERB). The Union would like the issue of tariffs adjustment to resolved in such a manner that future electricity price increases do not cripple the economic viability and productivity of the whole agriculture sector.

Therefore, the ZNFU is requesting for special tariff considerations for its members that will encourage more efficient utilization of the ZESCO's electrical power system while providing electricity to the farmers at affordable economic prices. Such a tariff should take into consideration time of day, electrical load characteristics, the power supply quality and reliability requirements at different power demand points on a farm. The automatic tariff adjustment formula should be applied to verifiable actual incremental costs resulting from foreign exchange business transactions. In addition, the variables in the formula need to be examined very carefully.

In this way, Zambia would have a stable electricity tariff schedules which would allow realistic long range development planning in the agricultural sector. This would reduce the unnecessarily high electricity bills. The resulting savings would contribute to making Zambian agricultural produce competitive on a sustainable basis.

Appendix E2 ZESCO Position

ZESCO uses the automatic adjustment formula to adjust for inflation and keep tariffs constant in terms of the US dollar equivalent. In part, this was a requirement of the World Bank financing to ZESCO.

Currently the revenues from domestic electricity sales do not cover the total annual average costs of the Distribution and Customer Service Division of ZESCO.

The Management Performance Contract with the Government of the Republic of Zambia requires that the ZESCO tariffs should be based on projected average costs of operations and capital costs for generation, transmission , distribution and supply.

In addition, ZESCO is cognizant of its performance challenges relating to: access to electricity, billing system, energy conservation, emergency response, quality of power supply and voltage stability, and high frequency of unplanned power interruptions.

Therefore, for ZESCO to attain both economic efficiency and technical efficiency in the shortest possible time, it has set the following three primary goals for changes of future electricity tariffs:

1) Increase to ZESCO on a long run marginal cost basis
2) Subsidies for households with weak financial economy

3) Efficient use of electricity and streamlining of operations.

The revised tariff, in part, implements the above goals which will result in electricity price escalation. ZESCO recognises that price escalation is always interpreted by the customer as a negative message. To balance this image, the great advantages with the use of electrical energy to generate benefits and profits is to be emphasised.

Thus, an essential part of the implementation of the new tariffs is information to the customers. It is important that all customers get a comprehensive information of planned changes of prices and other conditions, both in short and long time range. This is of special importance for the agricultural and industrial customers as they often work with budgeted cost and long-term investment profitability calculations.

Appendix E3 ERB Decisions

The ERB has the responsibility to see that the undertakings earn a reasonable rate of return on their investment that is necessary to provide good service, and that the consumer is given affordable quality service. Thus the Board must weigh and balance the needs of undertakings with those of different categories of consumers. The main rulings at the public hearing follow.

1) A three part, lifeline block tariff for residential consumers was approved with minor changes.
2) The entire pricing formula will be reviewed under an all-party settlement initiative to be spearheaded by the Board. This will make the ATAF suitable to the current economic environment by ensuring that it is fair to both consumers and the utility.
3) ZESCO should work out a tariff for farmers that takes into account the time of day when electricity is being used. The proposal must be submitted to the ERB before April 2001.
4) The Board will continue to monitor ZESCO's financial and technical performance through a special reporting system to be introduced .
5) February 1, 2001 is to be the effective date of the new revised electricity tariffs.

Appendix E4 World Bank Mission Observations

The mission made four observations relating to the rulings of the Board, namely:

1) The 16 % tariff increase on average will help maintain theretail tariff level in real terms because the Kwacha has significantly depreciated since the last tariff review in April 2000.
2) The delayed effective date from November 1, 2000 to February 1, 2001 will certainly cause considerable revenue losses to ZESCO.
3) Increasing the threshold of the lifeline tariff from 100 to 300 kWh/month will heavily subsidise some better-off residential customers.

4) Principles of the ATAF (announced by ERB in May 1999) should be maintained in ERB's future reviews.